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1100 Seventeenth Street, N.W. Washington, D.C. 20036

SUBJECT: Optical Technology Experiment System Steering Group Meeting, GSFC October 17-18, 1967 Case 710

DATE: November 3, 1967

FROM: S.L. Penn
D.B. Wood

ABSTRACT

The results of a meeting of the Optical Technology Experiment System Steering Group on October 17-18, 1967 at GSFC are reported. The Group's purpose is to help define an appropriate Optical Technology Program for NASA and to determine the participation of the various Centers. Points brought up by NASA Headquarters and the Centers are presented along with some preliminary thoughts of the authors on critical problem areas.

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MEMORANDUM FOR FILE

On 17 and 18 October, the authors attended the OTES* (Optical Technology Experiment System) Steering Group Meeting #2 at GSFC. Also present were representatives from Headquarters offices in OART, OSSA, OMSF, and OTDA and from Centers ERC, LaRC, GSFC, and MSFC. The meeting was chaired by Col. H.L. Anderton, who heads the Communications and Tracking Branch of OART. The goals of the committee are, broadly, to help define an appropriate Optical Technology Program for NASA and to determine the Centers' respective roles in carrying it out. The main reason for this meeting was to review the recommendations of two proposals, by the Chrysler and Perkin Elmer Corporations, as to what concepts an OTES should embrace and what experiments should be approved for further definition.

The meeting began with each Headquarters Office expressing its thoughts on the Optical Technology Program, with free questioning and discussion from the participants. Some of the key points brought out were:

1) OART has an FY68 budget of about $4M for all AAP experiment definition, including that for OTES.

2) A need exists to determine whether and when more competition ought to be brought into the OTES program. Perhaps a dedicated, non-profit group would be the ideal body to work on the design of large space telescopes.

3) The Steering Group should look into the need for development of optical technology in other areas besides those recommended by the contractors (primarily, large mirrors and lasers), e.g., corner reflectors.

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*OTES - an as yet incompletely defined set of experiments, to fly on one or more earth orbital missions, to provide NASA with the technology to meet its long term astronomy and space communications needs.

4) Mixed feelings exist on how far OTES should go in directly serving the needs of science and applications programs; i.e., should all space technology experiments later be usable for scientific or applied research? It was agreed that while much of development should be oriented to the satisfaction of the goals of other Program Offices and the scientific community, some technology ought simply to be pursued for its own sake with the confidence born of experience that as new devices and techniques evolve applications spring up to take advantage of them. (Perhaps this sort of activity is not appropriate to OTES, though.) Wherever the costs of designing a technological experiment to be useful for subsequent scientific or applied research were not excessive, such design should be encouraged.

5) OSSA has a long range (1979-1985) objective of establishing a National Astronomical Space Observatory (NASO). Several intermediate programs (OSO, OAO, ATM, etc.) are regarded as stepping stones to this goal. Mention was made of an "independent" group (the Spitzer Committee) which has been set up to determine NASO requirements and how they should be met. It is hoped that OSSA sees the value in having some degree of manned participation in the operation of a large telescope in space, if only to assure its long term operation and flexibility of use. In that case, every effort should be made to take advantage of OTES activities and the Steering Group's capabilities in OSSA planning, at the very least to the extent of coordination between the Steering Group and Spitzer's group. OSSA took an action item to look into this matter.

6) OTDA has an interest in being able to meet whatever data requirements future interplanetary flights may impose and wants to keep abreast of the potential of lasers in this area. It was pointed out that they might also, some day, need to incorporate a laser system with their ODRN (Orbiting Data Relay Network), planned for synchronous altitudes, for continuous transmission at high data rates of earth observation information from vehicles in low earth orbit.

The Centers then discussed in some detail their active optical programs, competence, and conceived roles. Some of the more interesting items were:

1) ERC is funding the contractual development of "space qualified", He-Ne lasers. While not intended for use on

any particular missions, their development and test will be carried out to general space flight specifications. ERC also claims to be working on lasers that emit "mode locked" pulses only 10^{-11} to 10^{-12} seconds wide at "high" duty cycles, with the potential for communications at correspondingly high bit rates.

2) GSFC's interests are primarily in the communications aspects of OTES. They already have considerable experience with laser tracking of satellites carrying cube corner retroreflectors. Current Goddard plans include irradiating the Echo satellite with a 10.6μ CO_2 laser and attempting heterodyne detection of the return signal.

3) LaRC has been pursuing some 12-15 tasks geared toward a large diffraction limited mirror for a Manned Orbiting Telescope. Its current interests are in mirror figure measurement and atmospheric effects on laser propagation.

4) MSFC has been a key center in the OTES Program to date, having supported contractual studies in this area for several years. Their internal work has included atmospheric propagation and beam pointing studies.

5) Several laser tracker sites in addition to those already in use by GSFC are under development. ERC hopes to use the Smithsonian site at Mt. Hopkins, Arizona and MSFC is building one on a mountain near Huntsville, Alabama.

Following these discussions, an attempt was made to evaluate the OTES experiments proposed by Chrysler and by Perkin Elmer, to categorize them as "approved" or "disapproved", and to determine whether more study or a restatement of the experiments was required. For this review, the experiments were lumped into the following three areas, which were considered in turn, namely:

1. Atmospheric propagation
2. Pointing and tracking (laser)
3. Large mirror technology

The evaluation proved more difficult than anticipated, so it was decided, instead, to have the experiments and related problems studied by two subcommittees, which would then make recommendations for consideration at a follow-up meeting of the Steering Group on Nov. 15. D.B. Wood will participate in the mirror technology sub-group, headed by G.B. Graves of LaRC,

and S.L. Penn in the laser communications sub-group, headed by J.L. Randall of MSFC. The sub-groups were charged with defining and organizing the optical technology work required in their respective areas and the participation of the various Centers. They were told not to restrict themselves to any preconceived notions attached to the term OTES. It is the opinion of the authors that these investigations should still relate clearly and directly to the specific goals of space astronomy and high data rate space communications, to help maintain a proper balance between SRT and AAP supported work.

An important area for the sub-groups to address is which experiments must be done in space and which can be done or simulated adequately on the ground. The Steering Group had no obvious consensus on this matter. The authors can see where border line cases might exist where simulation on the ground is feasible, but demonstration in space still seems warranted. Such a case might be one in which it is desirable to leave no uncertainty as to the prospects for success, e.g. in the design of an operational laser communication system for a manned interplanetary mission. And cases might exist where cost or convenience factors do not preclude a test which would be more impressive if done in space than if simulated on the ground even though the latter were possible.

The arguments on lasers vs microwaves for certain applications are still not resolved to the satisfaction of the technical community nor are they likely to be resolved by the sub-groups. A flexible approach, allowing for greater enlightenment at a later date to play a deciding role, should be attempted, along with an effort to minimize the influence of individual and organizational biases.

Some sentiment was expressed for doing atmospheric propagation work with lasers as soon as possible and leaving the flight of large mirrors until later. It was generally agreed that laser activities would be more appropriate to synchronous than low earth orbits. The low orbits would pose difficult tracking problems and rapidly changing path characteristics. Going to synchronous orbit, however, with a manned vehicle might have to be justified for other reasons besides laser communications tests. Going to synchronous orbit unmanned for that purpose is not out of the question, but additional sophistication of the equipment to automate it would be required. From the standpoint

of most valuable scientific return, astronomy would still seem to justify an effort to fly a large mirror in low earth orbit as soon as possible, with figure measurement equipment, but, perhaps, without assurance of diffraction limited capability.

S.L. Penn

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Subject: Optical Technology Experiment System Steering Group Meeting, GSFC, Oct. 17-18, 1967

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